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Hypermedia Personal Computer Communication System: Fujitsu Habitat

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Hypermedia Personal Computer Communication System: Fujitsu Habitat

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This paper describes the technological development of Fujitsu Habitat, and outlines its structure and features. Fujitsu Habitat is a new type of personal computer communication system that supports multimedia processing. It synchronously generates pictures, sounds, and characters — a feat which cannot be performed by conventional personal computer communication systems.

This system is operated by linking Fujitsu's FM TOWNS hypermedia personal computer to a UNIX host machine.

Communication between the host and terminals is done using a unique communication protocol that ensures high-efficiency and high-reliability data transmission.

1. Introduction

The FM TOWNS hypermedia personal computer has been on the market since February 28, 1989. The standard model comes with a 540-Mbyte CD-ROM drive and powerful audio-visual functions to facilitate hypermedia processing.

This paper describes Fujitsu Habitat, which is a network based multi-player game utilizing the hypermedia capabilities of the FM TOWNS. Fujitsu Habitat creates an imaginary world in a network host computer. People having access to an FM TOWNS can live in that world and interact with other users.

Each user is given a body and an interchangeable head. Users can talk with each other and move around in a virtual world-animation. Fujitsu Habitat is an interesting and very enjoyable audio-visual multiplayer game. The present population of Fujitsu Habitat is about 2 000 and is expanding.

Currently, this service is offered as a personal computer communication service of "NIFTY-Serve" by N.I.F. Corp. (a joint corporation of Fujitsu and NISSHO IWAI Corp.).

Although Fujitsu Habitat is just a game at this stage, some people have formed companies in that world, and are even doing business. This shows how a hypermedia network society can evolve, and how it may become useful. It is a challenging experiment and we are very interested in seeing how it develops.

Habitat was originally developed by LUCASFILM Ltd.[1] in the U.S.

Fujitsu licensed it from LUCASFILM Ltd. and then modified it into Fujitsu Habitat.

We have modified all the pictures (e.g. heads, bodies, scenery, and buildings) and audio data to suit Japanese users.

The functional distribution between the network host computer and the FM TOWNS[2] has been redefined to fully utilize the hypermedia capabilities of the FM TOWNS. All the data for pictures and sounds is contained in a CD-ROM loaded in all participating FM TOWNS computers. Communication is very efficient because the only information that needs to be sent is information required to select pictures

Fujitsu Habitat is based on LUCASFILM technology. The UNIX operating system was developed by and is licensed by AT&T.

Table 1. Basic commands

Command	Functions
GET	Get object
PUT	Place object
DO	Take action (e.g. sit on chair, open/close door)
GO	Walk
HLP	Get help message
WSP	Wisper to specified person

Table 2. Function commands

No.	Functions
1	Change Avatar
2	Change sound or music
3	Raise right hand
4	Raise both hands
5	Punch
6	Jump
7	Change direction
8	Go back to menu screen and terminate Fujitsu Habitat

and sounds. This avoids the need to transmit bulky multimedia data. The communication protocol has also been improved to achieve higher transmission efficiency and reliability.

2. Outline of Fujitsu Habitat and its system

Fujitsu Habitat is an imaginary visual world created in a network. It consists of zones, some examples of which are the residential zone, downtown zone, park zone, forest zone, and dungeon zone. Each zone consists of more than ten interconnected regions. A region equals one screen display. For example, the downtown zone consists of a cafe, a bar, and toyshop. There are about four hundred scenes in total.

When a user subscribes to this system, he or she must first select a body and a head (available at the head shop) to form a character referred to as the user's Avatar. (An Avatar is the combination of a body and one of more than 1 000 ready made male, female, old, young, animal and monster heads.) The user can then start his and her life in Fujitsu Habitat through an Avatar from a condominium in the residential zone. Money to live on is given when the user

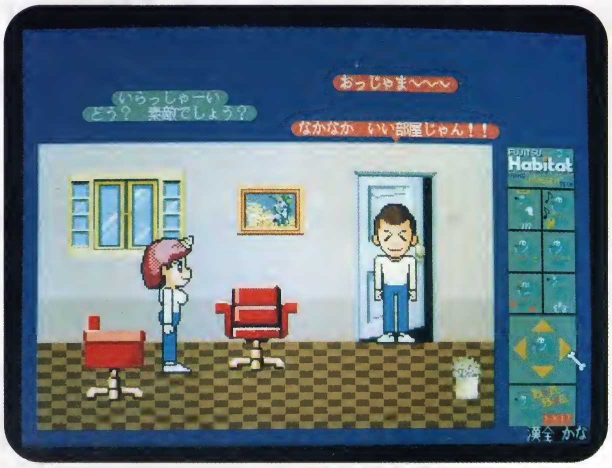


Fig. 1—Terminal screen (scene in a condominium).

subscribes. Users manipulate their Avatars by giving commands using a mouse. For instance, if a user gives a GO command while pointing to a place on the ground, his or her Avatar will walk to that place. If it is given a command to go to the edge of the screen, it moves to the adjacent area. If it is given a GET command for an object on the ground, it will pick it up. These basic commands are shown in Table 1. Table 2 shows function commands for other movements such as raising hands, changing direction, and punching.

When users meet other Avatar in the screen world, they can talk to the users of those Avatars through the keyboard (see Fig. 1).

In this imaginary world, an Avatar can go shopping with money and chat with friends. Many users can have simultaneous access to the same screen and thereby have an interactive experience in another world.

Figure 2 shows the network configuration of Fujitsu Habitat. It consists of the FENICS network (Fujitsu digital network) and public lines.

Fujitsu Habitat can be accessed at the standard national charges by connecting an FM TOWNS (hereinafter called a terminal) to an access point. The host center consists of the Fujitsu Habitat Center and the NIFTY-Serve Center.

Access to Fujitsu Habitat requires an ID card subscription to NIFTY-Serve. The NIFTY-Serve Center is responsible for password control and

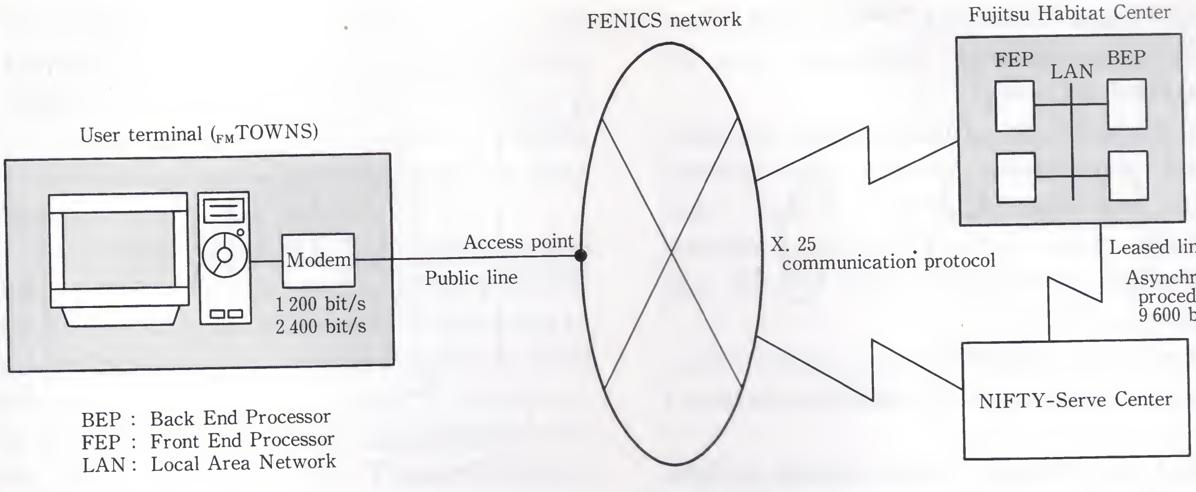


Fig. 2—Configuration of Fujitsu Habitat network.

Table 3. Service requirements of Fujitsu Habitat

Item	Improvement
Realtime processing	Use a process to share data between host and terminals that minimizes communication traffic.
Terminal operability	Make Fujitsu Habitat easy to use.
Expansibility	Use a program structure that allows the Fujitsu Habitat Center to be expanded into a multi-host system in anticipation of large increase in the number of users. Distribute processing between host and terminals to minimize software modifications even when the functions are extended.
High reliability	Localize troubleshooting and automated task recovery processing. Use a communication protocol suited to public communication networks.

accounting. To meet these service requirements, improvements have been made to realtime performance, terminal operability, expansibility, and reliability. These improvement are outlined in Table 3 and are discussed in the next chapter.

3. System configuration

3.1 Concept of function distribution between host system and terminals

The functions of Fujitsu Habitat are distributed between the host system and terminals. A very important aspect of designing a distributed processing system is how to assign the functions between the host and terminals. The response time is greatly affected by this assignment.

When transmitting visual data, it is usually important to minimize the amount of data to be sent. In the case of Fujitsu Habitat, direct transmission of visual data would involve more than 10-Kbyte per transaction. This would not be practical from the viewpoint of response time. To solve this problem, the image data of Fujitsu Habitat is stored in the terminal's CD-ROM. The parts of control information are controlled by the Fujitsu Habitat Center. Images are retrieved from the CD-ROM according to commands from the Fujitsu Habitat Center.

The same processing method is also used for musical tones and audio effects.

By adopting this method, this system has a response time short enough for a realtime system. This method gives the flexibility required to immediately act on the control information sent from the Fujitsu Habitat Center in response to events occuring in Fujitsu Habitat.

The host program controls object information indicating the following: whether an object (e.g. a tree, building, or head) can be picked up or carried, how various objects can interact with each other, Fujitsu Habitat's world map information, and Avatar information (indicating user IDs, and the assets and positions of Avatars). It also issues commands to the terminals.

The terminal program processes animation (e.g. walking, jumping, and hand raising) and

generates audio effects (e.g. a bang when a door is closed) according to commands from the Fujitsu Habitat Center.

To improve the efficiency and reliability of data transmission between the terminal program and host program, a unique communication protocol called the Fujitsu Habitat-link protocol (hereinafter called H-Link) was developed (see section 3.4).

We will now outline the total system processing flow for the function distribution mentioned above.

The Fujitsu Habitat system consists of three major phases: the log-in phase, service phase, and log-out phase.

In the log-in phase the host transfers the user ID and password transmitted from the terminals to the NIFTY-Serve Center. It then receives the sendback information from the NIFTY-Serve Center after checking it against the user control information kept there. The host then issues a request for the accounting information. While this is happening, the terminal displays a Fujitsu Habitat picture (see Fig. 1) and waits for the user's input. When it receives the input the terminal changes to the service phase.

In the service phase, the terminal processes instructions from the mouse and conversation text input from the keyboard. It then post the actions and associated coordinates to the Fujitsu Habitat Center as an internal command. The host then does the following: analyses the transferred internal command, determines whether the command can be carried out, determines the consequences of the action (if executable), and finally transfers the results (i.e. the changes to be made to the animation) as an internal command. The terminal then processes the animation and waits for the next input from the user.

In the log-out phase, the user issues the log-out instruction; then the terminal posts it to the Fujitsu Habitat Center and disconnects the line. The host updates the user control information to the latest user status and informs the NIFTY-Serve Center that the accounting information has been obtained.

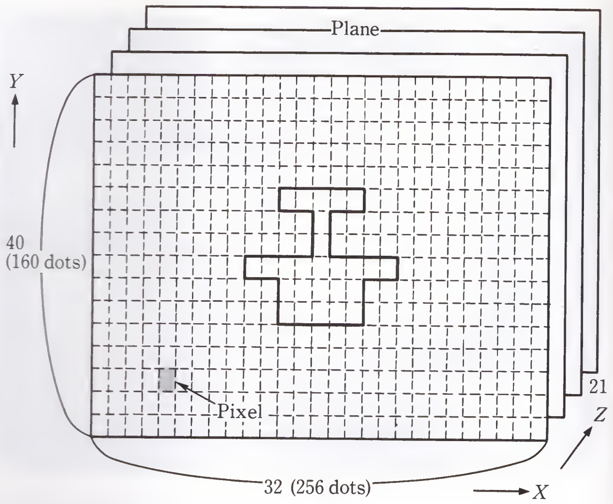


Fig. 3—Map configuration.

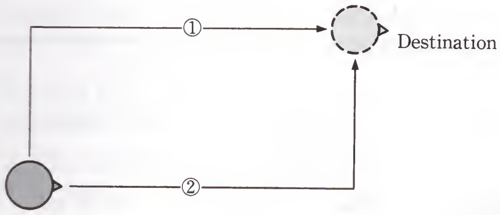


Fig. 4—Avatar movement route (top view).

3.2 Screen control

The screen control function enables display of a smoothly animated three-dimensional world. This function achieves this by mapping and by separating objects into parts. The attractiveness and realism of the Fujitsu Habitat display owes much to this function.

The map is an area in the host which indicates how an object is to be displayed and positioned in a region. As shown in Fig. 3, it is a three dimensional expression with X being the length, Y the height, and Z the depth. Objects in the screen background are positioned in the deepest plane. Movable objects and Abatars are positioned in other planes. The terminal draws the screen in stages from the back plane to the front plane. This process superposes near objects over far objects. The map is also used to identify objects pointed out by the mouse.

When a user issues the GET command for an object on the screen, the terminal sends the object's X, Y coordinates and the command

type. (The terminal has no concept of depth and does not handle Z-coordinate data.) The host program then checks whether objects found in the Z planes at the X, Y positions are portable. (The planes are checked starting with the front plane).

For a GO command, the host program checks whether the specified position is already occupied. Route checks are made in two ways to determine whether a specified route is clear (see Fig. 4). When a movement is completed, other Avatars in the scene are reoriented so that they all face the screen. This reorientation is made in preparation for the next move instruction from the mouse.

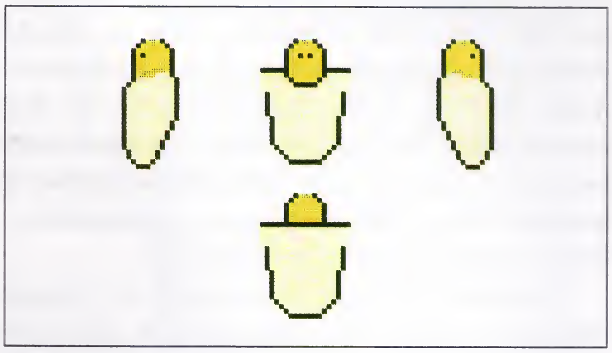
The FM TOWNS has a powerful sprite function, and the terminal program makes full use of it to display animations. To give depth to the scene, display priority is given to objects at the front. The nearer an object is to the back plane, the lower its display priority. Object image data is divided into small segments to enable smooth animation of a variety of movements. For example, an Avatar consists of fourteen segments, each of which is further divided into four patterns corresponding to views from the front, rear, right, and left. Further more, each pattern can be viewed from sixteen different angles (see Fig. 5).

When making an animation, the terminal draws the parts according to commands from the host. When an Avatar walks or raises its hand, all necessary control information specifying the parts to be moved for each phase and the delays between displays is simultaneously managed. The commands that must be simultaneously executed are collectively referred to as cell data. The terminal program begins an animation by referencing this data. The selection and display order of cell data can be changed by a command from the host. An action such as "face forwards and walk backwards" is processed by modifying the host program.

3.3 System control

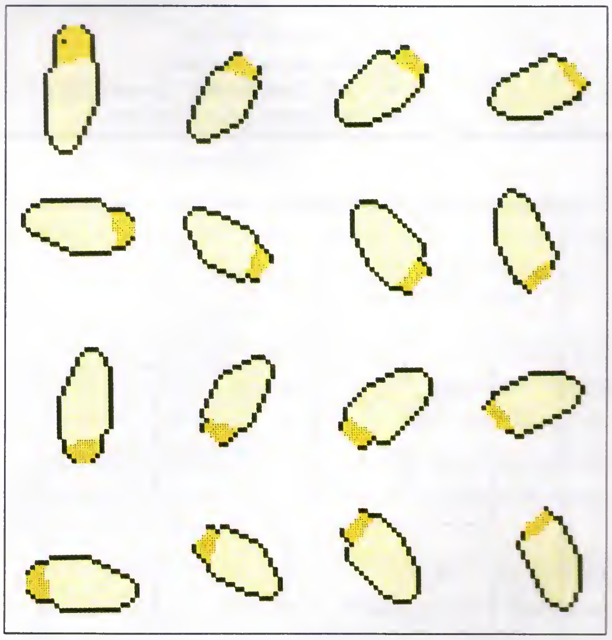
This section introduces the concept of multi-host distributed processing, file control,

Left	Front	Right
	Rear	



a) Four views of a body

0°	30°	45°	60°
90°	120°	135°	150°
180°	210°	225°	240°
270°	300°	315°	330°



b) Further divisions of body views

Fig. 5—Object parts.

and impediment control of the host computer system.

In anticipation of future increases in the number of users and communication paths, the Fujitsu Habitat Center was built as a multi-host structure using the LAN system to balance

the load between host computers. The processing is distributed as shown in Table 4.

For inter-task communication using a multi-host configuration, it is usually necessary for the inter-task communicators to decide which host should have the other task. Furthermore, because LAN communication of this system is made at the inter-host communication section, an application program can be produced without concern for the physical configuration. Figure 6 illustrates this concept.

The DB control section controls the Fujitsu Habitat data base. This data base is a collection of smaller data bases, for example, the user ID; user information data base for names; region data base for the region connection status; object data base for region manipulation for objects; and the mail, bulletin board, and document data bases for the text of memos. This information is controlled using C-ISAM[note)], and deadlocks are avoided by using a general exclusive control system.

Table 4. Distribution of processing

Host type	Major distributed functions
FEP (Front End Processor)	Communication control section User control section NIFTY-Serve control section Inter-task communication section LAN communication section
BEP (Back End Processor)	Region control section Data base access section Inter-task communication section LAN communication section

We will now describe the fault control method used in this system.

During online operation, if an application task (consisting of a user control section and a region control section) fails to continue processing due to an abnormality (e.g. a process contradiction), the work can still be continued without online disconnection. This is achieved by activating the task recovery function, which recovers the failed task only (see Fig. 7).

Task recovery processing is done in the following stages: return of stored data in the task, garbage collection such as enforced unlock-

Note: C-ISAM is a registered U.S. trade mark of INFORMIX SOFTWARE Inc.

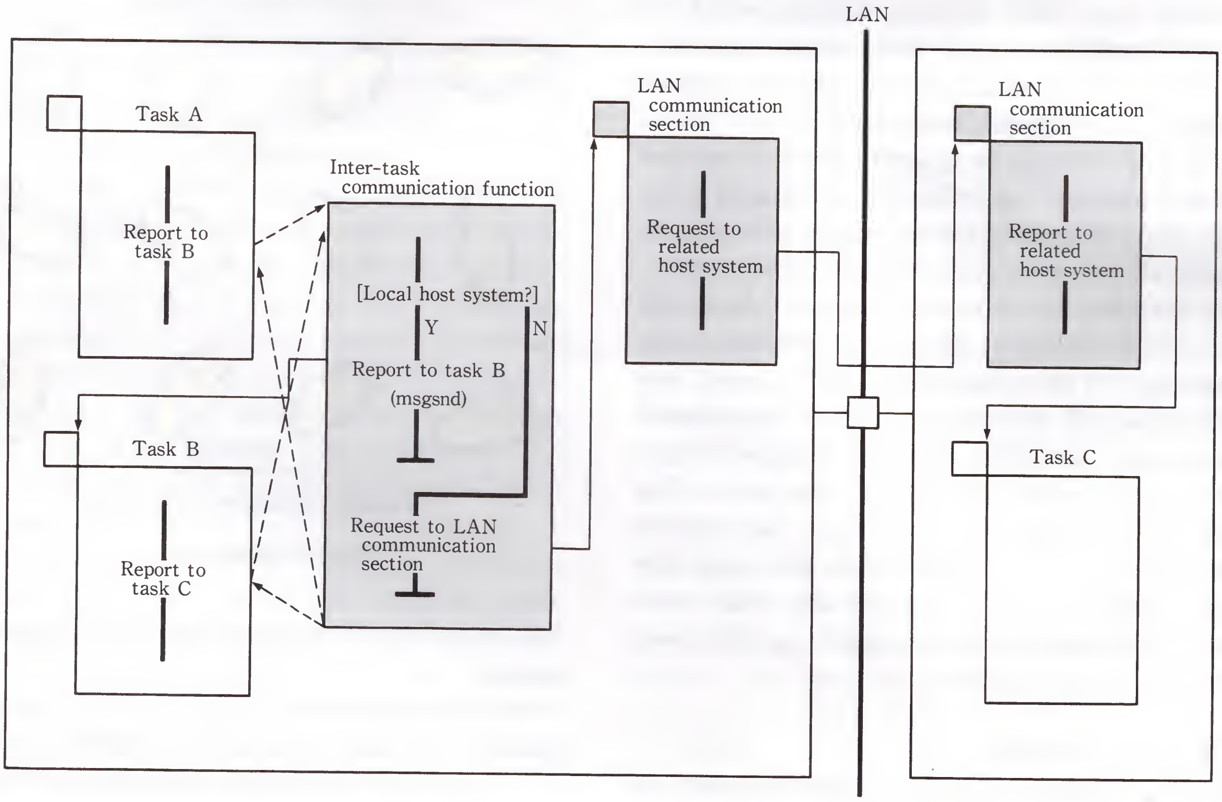


Fig. 6—Concept of inter-task communication.

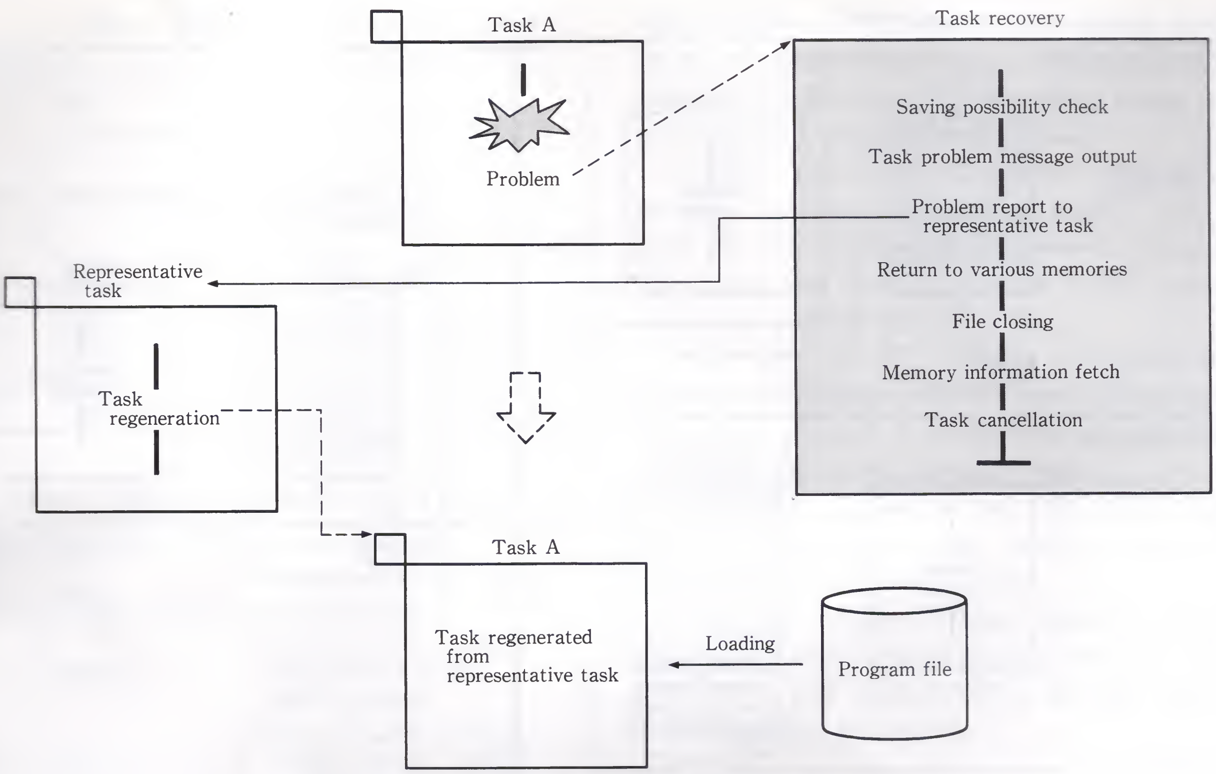


Fig. 7—Concept of task recovery.

ing of locked resources, collection of memory information required for failure analysis, output of a message giving the error cause, and program reloading.

Task recovery processing does not perform control line tasks other than application tasks.

For a multi-host configuration, system monitoring must be integrated to reduce the burden on the center operator and to enable the system controller to monitor the total system. In this system, a master/slave relationship is established between hosts, and work can be done through the master host. The master/slave relationship is stored in the host definition file, so the starting program must first read the memory. The console terminal of the master host not only stores the system control inputs for start and termination of Fujitsu Habitat, but also displays messages received from each program. The slave host accepts non-interference commands, for example, running status indication commands (see Fig. 8).

3.4 H-Link protocol

This section describes the concept and characteristics of the H-Link communication protocol, used between Fujitsu Habitat and terminals.

3.4.1 Background

Fujitsu Habitat was designed to transfer pictures, music, and sound effects between the host and terminals with the minimum of data transmission.

Another design target was low-cost yet high-reliability data transmission. Because data exchanged between the host and terminals is not image information but control information, data transmission errors might severely disrupt the service.

Fujitsu Habitat can be accessed via public communication networks using general purpose hardware for personal computer communications.

Personal computer communication is usually performed using communication protocols, for example, asynchronous procedures and XMODEM (see Table 5), or using special hardware such as an MNP[note)] modem. Both these methods have advantages and disadvantages

Note: MNP is a registered trade mark of Microcom Inc.

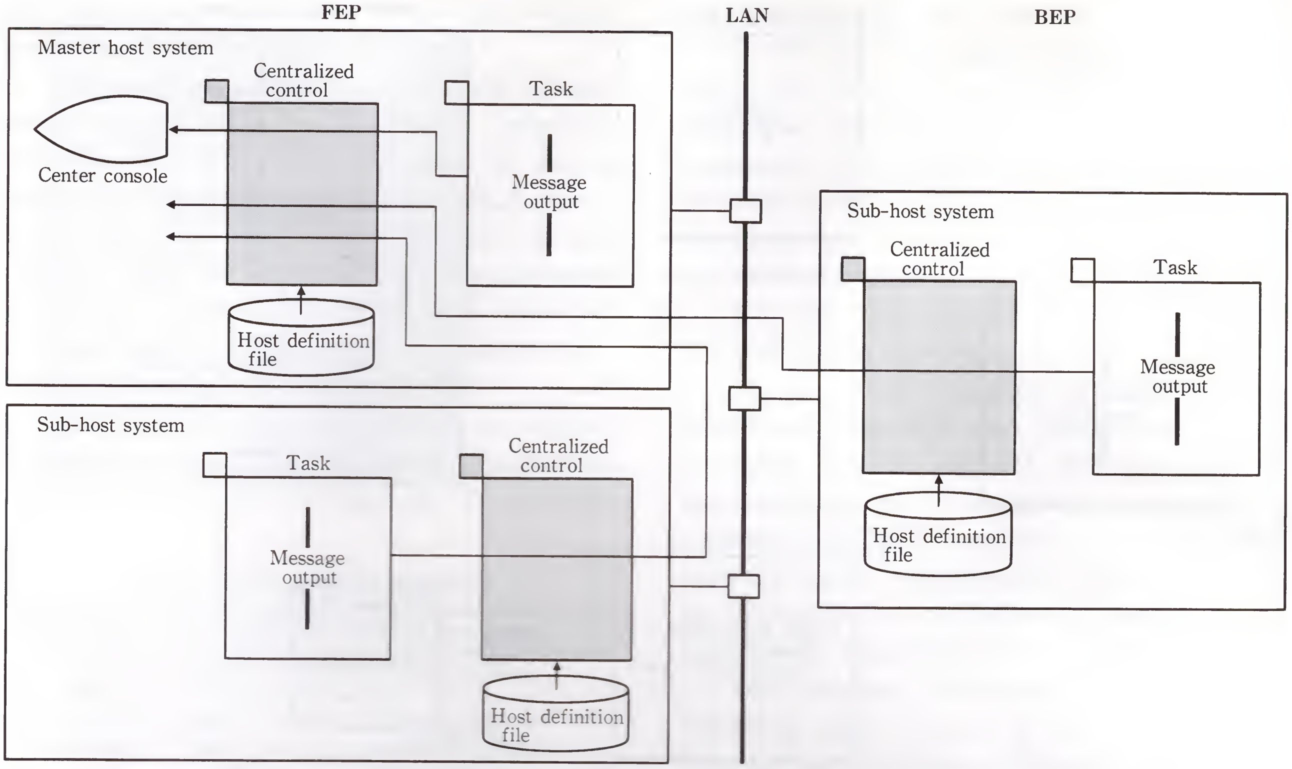


Fig. 8–Centralized supervision at Fujitsu Habitat Center.

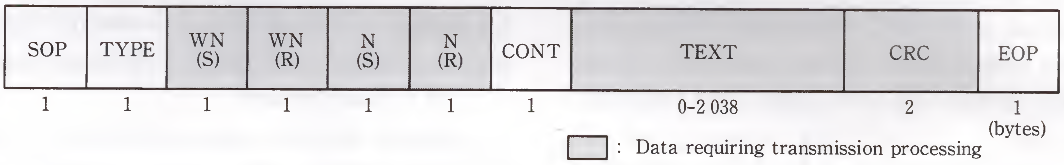


Fig. 9–H-Link protocol data format.

Table 5. Comparison of communication protocols

Communication protocol	Efficiency	Reliability	Cost	General evaluation
Asynchronous procedures	Low	Low	Low	Low efficiency and reliability
XMODEM	Low	Medium	Low	Low efficiency due to confirmation of ACK/NAC transmission per packet
MNP mounted modem	High	High	High	Too expensive due to adjustments required for user's hardware

regarding efficiency, reliability, and running costs.

To satisfy the design goals of efficiency, reliability, and economy for Fujitsu Habitat, we developed the H-Link communication protocol.

3.4.3 Data format of H-Link protocol and its characteristics

Figure 9 illustrates the data format of H-Link protocol.

Conversational messages, image control, and other information is transferred between host and terminal in this format. One information packet includes control information and transmission data having a variable word length. The maximum amount of data in one packet is 2 048 bytes. Each packet starts with SOP (Start Of Packet) and ends with EOP (End Of Packet). The type section of each packet indicates the type of information it contains (see Table 6).

If a message is too large for one packet, the

Table 6. Functions of TYPE section

TYPE	Information type	Function
"I"	Data (information)	Used for normal data
"P"	Data (polling)	When the number of windows reaches a specified value
"R"	Response request (request)	Confirmation request
"A"	Status report (ACK)	Normal status response
"N"	Resend request (NAK)	Packet resend request

Table 7. Types and functions of CONT section

CONT	Information type	Function
"O"	ONLY	Indicates packet contains entire message
"F"	FIRST	Indicates packet contains first part of a multi-packet message
"M"	MIDDLE	Indicates packet contains middle part of a multi-packet message
"L"	LAST	Indicates packet contains last part of a multi-packet message

Table 8. Features of H-Link protocol

Targets	Characteristics
High transmission efficiency	Data can be transmitted and received as binary data. Window control enables continuous sending of packets. Capable of full duplex communication.
High reliability	CRC error detection. Confirmation of lost packets and overlaps using a sequence number. Non-response detection using time monitoring. Monitoring of non-communication and assessment of line quality at a rated distance.

remainder is transmitted using additional packets. For multi-packet messages, reception confirmation for each packet would lower the transmission efficiency. To overcome this problem, the required number of packets (window numbers) is determined by the host and terminal, and confirmation is made when all packets have been transmitted. The window serial number (WN) checks for logical errors in the received transmission. The packet serial number (N) prevents a packet from being lost or overlapped with another packet.

CONT (Continue) indicates whether a message continues in another packet, and is used by the receiver to assemble the packets. The types and functions of the CONT section are shown in Table 7.

The text section contains a transmission message or object control data. Transparent processing of data is performed to enable the sending and receiving of binary data.

The CRC section is the CRC value from SOP to TEXT. If a CRC error is detected, a retransmission request is made.

The use of the H-Link message format ensures a high transmission reliability and efficiency. The characteristics of this format are summarized in Table 8.

4. Conclusion

This paper has focused on the key technologies used in the Fujitsu Habitat system; it has also outlined the system configuration and programs.

This system was developed as a personal visual communication system. By minimizing the volume of data to be transmitted, it achieves a higher response speed than conventional graphic communication systems. This minimization and subsequent high speed was made possible by Fujitsu's large-capacity CD-ROM mounted personal computer FM TOWNS, and by the development of the H-Link protocol.

This service was initiated on January 26, 1990, and was initially provided free of charge. It was continued on a commercial basis starting from February 10, 1990. Within its first six months, more than 2 000 people ranging from eleven to sixty years of age had become users. All users, young and old, male and female, are enjoying themselves in Fujitsu Habitat. (Some enthusiastic members are reportedly spending more than 150 h/month on the program.) This new type of system for communication by personal computer is now attracting considerable attention.

Fujitsu is now developing a "Gameland" and a "Business Land" to further entertain the inhabitants of Fujitsu Habitat and other customers. These developments are expected to be completed within a year.

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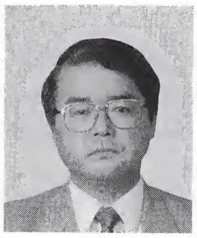

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